Forest Insect
& Disease
Leaflet
2

U.S. Department
of Agriculture
Forest Service

MOUNTAIN PINE BEETLE[1]

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F-701452

Outbreaks of the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, frequently develop in lodgepole pine forests that contain well-distributed, large diameter trees, or in dense stands of commercial-sized ponderosa pine (fig. 1). When outbreaks are extensive, one million or more trees may be killed each year. The periodic losses of high value, mature sugar pine and western white pine are less widespread but are still highly destructive.

Widespread tree mortality resulting from outbreaks of several years' duration can influence the ecosystem. Often, infestations will almost totally deplete merchantable pine forests and, in some cases, have converted valuable forests to less desirable timber species. Sometimes forested areas are converted to grasses and shrubs. In addition fire danger is increased because of excessive amounts of dry fuel in dead trees.

The mountain pine beetle is found over a wide area ranging from the Pacific Coast eastward through the Black Hills of South Dakota and from northern British Columbia and western Alberta southward to northwestern Mexico. Its habitat ranges in altitude from 2,000 feet (1600 m) in the

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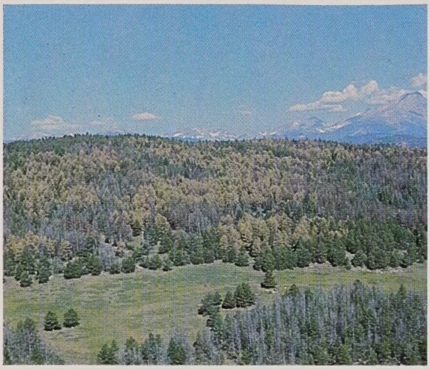
more northern latitudes to 11,000 feet (3350 m) in southern California.

Hosts and Damage

In addition to the four major host trees (ponderosa, lodgepole, sugar, and white pines), the mountain pine beetle occasionally infests limber, Coulter, foxtail, whitebark, pinyon, and bristlecone pine. Scots pine, an exotic of North America, is highly susceptible to attack. Douglas-fir, true firs, spruce, and larch may occasionally be attacked, but they are not true hosts, and brood rarely develops. These attacks on nonhost trees usually occur when nearby pines are heavily infested.



F-701453

Figure 1.—*Destructive mountain pine beetle outbreak in ponderosa pine.*

The first signs of infestation are pitch tubes on the trunks of living trees. These pitch tubes appear during summer months, and mark the places where female beetles have entered the tree (fig. 2). Pitch tubes are cream-colored to dark red masses of resin, mixed with boring dust, and are 1/4 to 1/2 inch

F-701454

Figure 2.—*Pitch tubes made by mountain pine beetles.*

(6 to 13 mm) in diameter. Large tubes, 3/4 to 1 inch (19 to 25 mm), widely scattered over the trunk, may indicate that beetles failed to successfully invade the tree. Careful examination of trees that have been successfully attacked will reveal the second sign—dry boring dust (similar to fine sawdust) in bark crevices and around the tree base.

One to several months after attack, bluestaining fungi that are carried into the trees by the beetles begin to discolor the sapwood.

Needles on successfully infested trees may start to fade and change color several months to almost a year after beetle attack. The sequence of color changes is green to yellowish green, then sorrel, and finally red and rusty brown (fig. 3). Fading in the top may be the first sign of attack on large sugar pines since initial infestation on

such trees usually occurs high on the tree.

Woodpeckers, in their effort to reach larvae under the bark, make individual holes in thick bark trees, or they may partially or completely remove thinner bark. These signs, plus the resulting pile of bark flakes around the base of the tree, are good evidence of infestation.

F-701455

Figure 3.—*Trees killed by mountain pine beetles that attacked 1 year previously.*

Life Stages and Development

Mountain pine beetles pass through the egg, larval, pupal, and adult stages during a typical life cycle of 1 year. All stages of the life cycle are spent under the bark of infested trees, except for a few days when adults emerge and fly to new trees.

At high elevations where summer temperatures are cool, 2 years may be required to complete the life cycle, and in California, two generations may be produced in 1 year in low elevation sugar pine.

The tiny, pearl-white eggs are laid along the sides of straight, vertical, frass-packed egg galleries constructed by the females (see cover). These galleries are mostly in the inner bark, but slight scoring of sapwood also occurs. When fully constructed, galleries will range from 6 to 30 inches long (15 to 70 cm).

Most eggs are laid in July and August, but a few are laid in the fall or early spring. The latter are generally due to egg gallery extension or parent reemergence and reattack. Usually the egg stage lasts 1 to 2 weeks.

Larvae feed on the inner bark (phloem), constructing galleries that extend at approximately right angles to the egg galleries. The legless larvae are white with tiny brown heads and will be found from August to the following June. When fully developed, larvae excavate oval cells inside of which they transform into pupae, then into adults (fig. 4). Prior to emergence, adults feed within the bark.

F-701456

Figure 4.—*Egg gallery, larvae, and pupae of 10-month-old mountain pine beetle brood.*

Several feeding chambers may coalesce so that adults assemble in groups of various numbers. One or more beetles will then make an exit hole from which several adults will emerge. Exit holes in the bark are very easily seen. Beetles will attack new trees within a day or two following emergence.

While adults are feeding in the inner bark prior to emergence, they pick up blue stain fungal spores in a special structure in their heads. Spores are carried to newly attacked trees where the fungi develop, eventually spreading throughout the sapwood (fig. 5). This hinders tree resistance to beetle attacks and makes moisture conditions under the bark more favorable for beetle development.

Unmated female beetles make the initial attacks and release odors, called aggregating pheromones, that attract males and other females until a mass attack is produced and the trees are overcome. Consequently, if beetle populations increase from year to year, the aggregating behavior results in larger and larger groups of trees becoming infested.

F-701457

Figure 5.—*Sapwood discolored by blue-stain fungi; heartwood is not stained.*

Initial attacks on most pine species occur at about eye level, and trees are usually killed by attacks of a single generation of beetles. Large sugar pines, in contrast, are attacked first in the crown, and two or three successive generations of beetles, each attacking a lower portion, may be required to kill the tree. Attacks on small sugar pine are similar to those on ponderosa and lodgepole pines.

Factors Affecting Outbreaks

There are a number of factors, seldom present alone, that contribute varying amounts of pressure on endemic and epidemic populations of beetles. Principal ones are:

Food Supply.—This is perhaps the key factor regulating populations of the mountain pine beetle. Through some survival mechanism, beetles frequently but not always select the larger trees, where food is likely to be most abundant. Adequate food, most likely found in large diameter trees during better than minimum moisture periods, remains a major requirement for infestation buildup. After larger trees are killed, beetles infest smaller and smaller trees, where phloem is thin. When this happens, beetle populations decline and epidemics subside. There is no clear-cut evidence that mountain pine beetle epidemics develop because of drought or in heavily mistletoe-infected stands. Sugar pine and white pine may be exceptions since drought or snowbreakage are believed to trigger epidemics.

Loss of attacking beetles.—This is due to beetles failing to reach a host tree or failure to initiate attack once on the tree. This loss is difficult to measure but is believed to be considerable at times.

Tree resistance.—Some pines produce so much pitch at the attack site, or in the egg gallery, that a brood cannot be established. The number of attacking beetles, health of the tree, and weather that prolongs the attack period are major factors that interact in tree resistance.

Nematodes.—These microscopic internal parasitic worms can reduce or prevent egg production in female beetles.

Birds.—Woodpeckers feed heavily on larvae in some trees, causing the bark to dry out which kills more beetles. Woodpeckers probably play an important role in reducing beetle numbers during endemic periods but there are not enough woodpeckers to control epidemics of the beetle. Several other species, including nuthatches, feed on beetles as they attack new trees.

Predaceous and parasitic insects.—A fly, *Medetera aldrichii* Wheeler, and two checkered beetles, *Enoclerus sphegeus* Fabricius (fig. 6) and *Thanasimus undatulus* Say, are common predators that may be very effective in reducing beetle numbers in individual trees but are seldom very effective in reducing mountain pine beetle infestations. A parasitic wasp, *Coeloides dendroctoni* Cushman, sometimes causes substantial larval mortality but only in trees with thin bark where its short ovipositor can reach the beetle larvae.

Competition.—Larvae compete for food and space not only with each other but with similar stages of other beetles. Larvae of round-headed woodborers (Cerambycids) occasionally destroy practically all mountain pine beetle broods under bark (fig. 7) as they devour everything in their vicinity.

Cold temperature.—Unseasonably low temperatures of about 0° F (-18° C) in early autumn or mid-spring, or those below -34° F (-37° C) (slightly lower for lodgepole pine) during winter months will greatly retard outbreaks. Unfortunately, such cold temperatures settle into low areas and some beetles survive where temperatures are not as severe, such as below the snow line, in thick-barked trees, and on slopes above the coldest temperature. These survivors form the nucleus for the continuation of existing or subsequent outbreaks.

F-701458

Figure 6.—*Redbellied clerid eating a mountain pine beetle.*

F-701459

Figure 7.—*Larvae of roundheaded woodborers have destroyed mountain pine beetle brood.*

Control

Control options available to the landowner depend somewhat on: size of the outbreak, age of the stand, size of the trees, and stand growing conditions. Generally, at about age 80 to 100 years, when tree diameters are 8 inches (20 cm) and larger and growth is beginning to slow due to competition, stand susceptibility increases. Phloem is still thick in large diameter trees, and ample brood can be produced.

Cultural control measures are the most efficient in these situations. Thinning dense stands of ponderosa pine to improve growth, or harvesting large diameter host trees, both ponderosa and lodgepole pine, lowers stand susceptibility and reduces beetle-caused mortality. Patch cutting in lodgepole pine stands creates a mosaic of age classes that keep mountain pine beetle-caused tree mortality low, and also provide openings that are beneficial to wildlife.

Once a large outbreak has developed it is very difficult to effectively carry out salvage logging of infested material to reduce future timber losses. Logging is always done after the beetles have attacked. Thought should be given to a combination of salvage, thinning valuable green stands, and removing large diameter trees in advance of the beetle attacks.

Chemical insecticides have been available for many years for direct control of beetles in infested trees. Direct control requires the combined efforts of all landowners within the designated control area, and treatment costs may exceed the wood product value of individual beetle-infested trees. Some landowners are unable or unwilling to spend the money needed for an effective program. When beetle outbreaks are large, cost effectiveness of direct chemical control may be hard to justify.

Individual, high value trees have been protected in recent years by the use of insecticides. Spraying trees of choice prior to beetle attack does not require united effort by forest landowners, nor is the value of the tree lost, as in direct chemical control.

Insecticides used for direct control or preventive sprays are reviewed periodically by the Environmental Protection Agency. Therefore, persons contemplating use of insecticides should obtain the names of materials currently

registered for use. This information can be obtained from any of the following:

USDA, Forest Service, Forest Insect and Disease Management

P.O. Box 2417
Washington, DC 20013

11177 W. 8th Avenue
Box 25127
Lakewood, CO 80225

Federal Bldg.
324 25th St.
Ogden, UT 84401

319 SW Pine St.
P.O. Box 3623
Portland, OR 97208

Federal Bldg.
Missoula, MT 59801

Federal Bldg.
517 Gold Ave., SW
Albuquerque, NM 87102

530 Sansome St.
San Francisco, CA 94111

or by writing to the local Extension Service, or to your State College or University.

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Although this report discusses research involving pesticides, such research does not imply that the pesticide has been registered or recommended for the use studied. Registration is necessary before any pesticide can be recommended. If not handled or applied properly, pesticides can be injurious to humans, domestic animals, desirable plants, fish, and wildlife. Always **read** and **follow** the directions on the pesticide container.

PROTECT

Use Pesticides Safely

FOLLOW THE LABEL

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